1 stepped pressure equilibrium code : ex00aa

Contents

1.1 outline

1. Extrapolates interface geometry to construct magnetic axis.
2. This routine is formally redundant, but it is useful to keep as it provides an example of how to extrapolate the interface geometry to construct a coordinate axis.

1.1.1 coordinate functions for small r

1. By exapanding $f(x, y)$ in a Taylor series about the origin, $f = \sum f_{i,j} x^i y^j$, assuming the polar coordinate transformation $x = r\cos\theta$ and $y = r\sin\theta$, and then using repeated applications of the double angle formulae, we see that analytic functions when expressed as functions of the polar coordinates, e.g. $f(r, \theta) = \sum f_m(r)\cos\theta$, must take the form

$$f_m(r) = r^m(a_{m,0}r^0 + a_{m,1}r^2 + a_{m,2}r^4 + a_{m,3}r^6 + \ldots) = \sum_{i=0}^{N-1} f_i r^{m+2i} \tag{1}$$

   for small r, where $N \equiv$`iextrap` degrees of freedom are assumed.

2. If the radial coordinate, s, is similar to r, then the above asymptotic form is unchanged and $f_m(s) = \sum f_i s^{m+2i}$.
3. In particular, the coordinate functions, R and Z, must have this functional form.
4. The degrees of freedom are constrained by fitting, using least squares, to $N \equiv$`iextrap` surfaces,

$$e = \frac{1}{2}\sum_{j=1}^{N} \left[f_{m,n}(r_j) - F_j\right]^2, \tag{2}$$

   where F_j is the harmonic at the j-th surface.

5. The linear equations to be solved are

$$\frac{\partial e}{\partial f_i} = \sum_{j=1}^{N} \left[f_{m,n}(r_j) - F_j\right] r^{m+2i} = \sum_{j=1}^{N}\sum_{k=0}^{N-1} f_k r^{m+2k} r^{m+2i} - \sum_{j=1}^{N} F_j r^{m+2i} = 0. \tag{3}$$

6. This is cast in standard form, $\mathbf{A}\cdot\mathbf{x} = \mathbf{b}$ where $x_k = f_k$,

$$A_{i,k} = \sum_{j=1}^{N} r_j^{m+2k} r_j^{m+2i}, \qquad b_i = \sum_{j=1}^{N} F_j r_j^{m+2i}, \tag{4}$$

   and is solved using the NAG routine `F04ATF`.

7. The coordinate origin is simply determined, by extrapolation, by setting $r = 0$ in Eq.(1).

1.1.2 logical control

1. From Eq.(1), only modes with $m = 0$ can contribute at the coordinate origin.
2. The asymptotic form is fit to the interface geometry, so `lextrap` ≥ 1 and `lextrap` $\leq$ `Nvol` is required.

1.1.3 comments

1. The coordinate axis is not required to coincide with the magnetic axis.

ex00aa.h last modified on 2012-07-05 ;